手　続　補　正　書
（法第１１条の規定による補正）

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4．補正の対象　　請求の範囲

５．補正の内容

（１）請求の範囲第１０頁第１項の「少なくとも３５０℃に到達した後、前記パルス電圧の電流密度を減少させる一方、」を「３５０℃に到達した後、前記パルス電圧の電流密度を減少させ、次いで、」に補正する。

（２）請求の範囲第１１頁第８項の「を備えることを特徴とする窒化処理装置。」を「を備え、前記温度検出手段（５８）は、前記熱処理炉（２４）内に配設したダミーワーク（３６）の放射温度を検出するダミーワーク用放射温度計（５４）と、前記ダミーワーク（３６）の接触温度を検出するダミーワーク用接触温度計（５６）と、前記ワーク（１２）の放射温度を検出するワーク用放射温度計（５２）と、前記ダミーワーク（３６）の前記放射温度及び前記接触温度の温度差を算出し、前記ワークの前記放射温度を前記温度差によって補正することで前記ワークの温度を算出するワーク温度算出手段（５８）と、により構成されることを特徴とする窒化処理装置。」に補正する。

（３）請求の範囲第１１～１２頁第１０項を削除する。

６．添付書類の目録　　（１）請求の範囲　　１０～１２頁

請求の範囲

[1] (補正後)熱処理炉(24)内にてワーク(12)を窒化処理する窒化処理方法であって、

前記熱処理炉(24)と前記ワーク(12)との間に1kHz以上の周波数からなる所定の電流密度のパルス電圧を印加し、発生するグロー放電によって前記ワーク(12)を加熱する第1ステップと、

前記ワーク(12)の温度が350℃に到達した後、前記パルス電圧の電流密度を減少させ、次いで、前記ワーク(12)の周囲に配設した発熱体(34)により前記ワーク(12)を所望の窒化処理温度まで加熱する第2ステップと、

からなり、前記グロー放電で生成された窒素イオン又は窒素ラジカルにより窒化処理を行うことを特徴とする窒化処理方法。

[2] 請求項1記載の方法において、

前記第1ステップでは、前記グロー放電及び前記発熱体(34)により発生する熱によって前記ワーク(12)を加熱し、

前記第2ステップでは、前記発熱体(34)による発熱量を前記第1ステップよりも高く設定して加熱することを特徴とする窒化処理方法。

[3] 請求項1記載の方法において、

前記第2ステップでは、前記パルス電圧の電流密度を除々減少させる一方、前記ワーク(12)の周囲に配設した発熱体(34)により前記ワーク(12)を所望の窒化処理温度まで除々に加熱することを特徴とする窒化処理方法。

[4] 請求項1記載の方法において、

前記第2ステップでは、前記ワーク(12)が所望の窒化処理温度に到達した後、前記窒化処理温度を維持させて窒化処理を遂行させることを特徴とする窒化処理方法。

[5] 請求項1記載の方法において、

前記パルス電圧の電流密度は、0.05～7mA／cm^2に設定することを特徴とする窒化処理方法。

[6] 請求項1記載の方法において、

前記パルス電圧の電流密度は、0．1～4mA／cm^2に設定することを特徴とする窒化処理方法。

[7] 請求項1記載の方法において、

前記ワーク(12)の温度は、前記熱処理炉(24)内に配設したダミーワーク(36)の放射温度及び接触温度の温度差を検出するとともに、前記ワーク(12)の放射温度を検出し、前記ワーク(12)の前記放射温度を前記温度差によって補正して求めることを特徴とする窒化処理方法。

[8] (補正後)熱処理炉(24)内にてワーク(12)を窒化処理する窒化処理装置であって、

前記熱処理炉(24)と前記ワーク(12)との間に1kHz以上の周波数からなる所定の電流密度のパルス電圧を印加してグロー放電を発生させるグロー放電発生手段(48)と、

前記熱処理炉(24)内に配設される発熱体(34)により前記ワーク(12)を加熱する加熱手段(50)と、

前記ワーク(12)の温度を検出する温度検出手段(58)と、

前記温度検出手段(58)によって検出された前記ワーク(12)の温度に基づき、前記グロー放電発生手段(48)による前記グロー放電の電流密度を制御するとともに、前記加熱手段(50)を制御する制御手段(74)と、

を備え、

前記温度検出手段(58)は、

前記熱処理炉(24)内に配設したダミーワーク(36)の放射温度を検出するダミーワーク用放射温度計(54)と、

前記ダミーワーク(36)の接触温度を検出するダミーワーク用接触温度計(56)と、

前記ワーク(12)の放射温度を検出するワーク用放射温度計(52)と、

前記ダミーワーク(36)の前記放射温度及び前記接触温度の温度差を算出し、前記ワークの前記放射温度を前記温度差によって補正することで前記ワークの温度を算出するワーク温度算出手段(58)と、

により構成されることを特徴とする窒化処理装置。

[9] 請求項8記載の装置において、

前記熱処理炉(24)は、

前記ワーク(12)を収容し、前記ワーク(12)との間でグロー放電を発生させる電極板(45)により囲繞される窒化処理室(32)と、

前記電極板(45)の外周部に前記発熱体(34)が配設され、隔壁(28)によって囲繞される加熱室と、

前記隔壁(28)の外周部に配設され、前記隔壁(28)を冷却する冷却液が供給される冷却手段(33)と、

を備えることを特徴とする窒化処理装置。

[10] (削除)

[11] 請求項8記載の装置において、

前記熱処理炉(24)は、横型熱処理炉であることを特徴とする窒化処理装置。

[12] 請求項8記載の装置において、

前記ワーク(12)は、クランクシャフトであることを特徴とする窒化処理装置。

Explanation of Amendment under PCT Article 34

1. In claim 1,

"after a temperature of said workpiece (12) arrives at least at 350 °C, while"

is amended to

"after a temperature of said workpiece (12) arrives at 350 °C, and then".

2. In claim 8,

"a control means (74) which controls said current density of said glow discharge effected by said glow discharge-generating means (48) on the basis of said temperature of said workpiece (12) detected by said temperature-detecting means (58) and which controls said heating means (50)."

is amended to

"a control means (74) which controls said current density of said glow discharge effected by said glow discharge-generating means (48) on the basis of said temperature of said workpiece (12) detected by said temperature-detecting means (58) and which controls said heating means (50),

wherein said temperature-detecting means (58) includes:

a dummy workpiece radiation thermometer (54) which detects a radiation temperature of a dummy workpiece (36) arranged in said heat treatment furnace (24);

a dummy workpiece contact thermometer (56) which detects

a contact temperature of said dummy workpiece (36);

a workpiece radiation thermometer (52) which detects a radiation temperature of said workpiece (12); and

a workpiece temperature-calculating means (58) which calculates said temperature of said workpiece by calculating a temperature difference between said radiation temperature and said contact temperature of said dummy workpiece (36) and correcting said radiation temperature of said workpiece with said temperature difference."

3. Claim 10 is canceled.

CLAIMS

1. (Amended) A nitriding treatment method for performing a nitriding treatment for a workpiece (12) in a heat treatment furnace (24), said nitriding treatment method comprising:

a first step of applying a pulse voltage having a predetermined current density at a frequency of not less than 1 kHz between said heat treatment furnace (24) and said workpiece (12) to heat said workpiece (12) by means of generated glow discharge; and

a second step of decreasing said current density of said pulse voltage after a temperature of said workpiece (12) arrives at 350 °C, and then heating said workpiece (12) up to a desired nitriding treatment temperature by using a heating element (34) arranged around said workpiece (12), wherein

said nitriding treatment is performed by means of nitrogen ion or nitrogen radical generated by said glow discharge.

2. The nitriding treatment method according to claim 1, wherein

said workpiece (12) is heated by heat generated by said glow discharge and said heating element (34) in said first step; and

heating is effected in said second step such that an amount of heat generated by said heating element (34) is higher than that in said first step.

3. The nitriding treatment method according to claim 1, wherein said current density of said pulse voltage is gradually decreased in said second step, while said workpiece (12) is gradually heated up to said nitriding treatment temperature by using said heating element (34) arranged around said workpiece (12).

4. The nitriding treatment method according to claim 1, wherein said nitriding treatment temperature is maintained to execute said nitriding treatment after said workpiece (12) arrives at said desired nitriding treatment temperature in said second step.

5. The nitriding treatment method according to claim 1, wherein said current density of said pulse voltage is 0.05 to 7 mA/cm^2.

6. The nitriding treatment method according to claim 1, wherein said current density of said pulse voltage is 0.1 to 4 mA/cm^2.

7. The nitriding treatment method according to claim 1, wherein said temperature of said workpiece (12) is determined by detecting a temperature difference between a radiation temperature and a contact temperature of a dummy workpiece (36) arranged in said heat treatment furnace (24), detecting a radiation temperature of said workpiece (12), and correcting

said radiation temperature of said workpiece (12) with said temperature difference.

8. (Amended) A nitriding treatment apparatus for performing a nitriding treatment for a workpiece (12) in a heat treatment furnace (24), said nitriding treatment apparatus comprising:

a glow discharge-generating means (48) which generates glow discharge by applying a pulse voltage having a predetermined current density at a frequency of not less than 1 kHz between said heat treatment furnace (24) and said workpiece (12);

a heating means (50) which heats said workpiece (12) by using a heating element (34) arranged in said heat treatment furnace (24);

a temperature-detecting means (58) which detects a temperature of said workpiece (12); and

a control means (74) which controls said current density of said glow discharge effected by said glow discharge-generating means (48) on the basis of said temperature of said workpiece (12) detected by said temperature-detecting means (58) and which controls said heating means (50),

wherein said temperature-detecting means (58) includes:

a dummy workpiece radiation thermometer (54) which detects a radiation temperature of a dummy workpiece (36) arranged in said heat treatment furnace (24);

a dummy workpiece contact thermometer (56) which detects a contact temperature of said dummy workpiece (36);

a workpiece radiation thermometer (52) which detects a radiation temperature of said workpiece (12); and

a workpiece temperature-calculating means (58) which calculates said temperature of said workpiece by calculating a temperature difference between said radiation temperature and said contact temperature of said dummy workpiece (36) and correcting said radiation temperature of said workpiece with said temperature difference.

9. The nitriding treatment apparatus according to claim 8, wherein said heat treatment furnace (24) includes:

a nitriding treatment chamber (32) which accommodates said workpiece (12) and which is surrounded by an electrode plate (45) for generating said glow discharge in cooperation with said workpiece (12);

a heating chamber which involves said heating element (34) arranged around an outer circumference of said electrode plate (45) and which is surrounded by a partition wall (28); and

a cooling means (33) which is arranged around an outer circumference of said partition wall (28) and to which a cooling liquid for cooling said partition wall (28) is supplied.

10. (Canceled)

11. The nitriding treatment apparatus according to claim

8, wherein said heat treatment furnace (24) is a lateral type heat treatment furnace.

12. The nitriding treatment apparatus according to claim 8, wherein said workpiece (12) is a crank shaft.